ECONOMIC CHARACTERISTICS OF THE R&D-INTENSIVE PHARMACEUTICAL INDUSTRY

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INTRODUCTION

This article presents a brief sketch of the economics of the R&D-intensive ethical pharmaceutical industry, highlighting its dynamic characteristics. The approach taken here minimizes the use of static analysis, and thus avoids the use of pure or perfect competition as an analytical tool. In this theoretical discussion, certain empirical studies will be cited as support for aspects of the theory being developed.

The theory discussed here will concentrate on allocative efficiency, but as with all discussions of allocative efficiency, elements of technical efficiency will automatically be involved and at least implicit recognition of these elements will be evident. The allocative efficiency concerns will be placed in a dynamic framework; we will be attempting to establish a notion of "dynamic pure competition" that has analytical and public policy implications. The concept of dynamic pure competition will describe a hybrid form of workable competition as the term is used by industrial organization economists.

AN OUTLINE OF A COMPETITIVE PROCESS

Before we get into an outline of the theory of pharmaceutical economics, we need to establish pure competition as a *competitive process*. Traditional microeconomics has assumed implicitly that the "natural state" is one that is depicted by pure competition. Deviations from the natural state occur as a disequilibrium, by the establishment of monopoly power, or through other often cited market failures. In cases of disequilibrium, the tatonnement will bring us to the equilibrium ideal of pure competition. Interestingly, the model of pure competition never really describes the process of the tatonnement (equilibration) but only the conditions necessary for the process to operate and the final equilibrium to result when the process has worked itself out.

The monopoly power deviation arises because the nature of "economic man" causes him or her to attempt to break out of a pure competitive equilibrium, or the equilibrating tatonnement process, and maximize his or her own economic situation relative to the rest of the world. The economic man will attempt to establish a monopoly power position through "entry barrier" meansemp (1a, 1b).

According to traditional microeconomics, then, the natural economic process is one that proceeds from the natural state of pure competitive equilibrium, or from where the necessary conditions exist for the pure competitive tatonnement process to take place, to conditions of monopoly.

The competitive process that is relevant here is one in which a naturally occurring monopoly is systematically faced with a pressure that erodes this position. It is a process that occurs on a continuum and which must be considered on the basis of changes through time. Reverting to the static sense, the economic concept of deadweight welfare loss is a representation of the social opportunity cost that is associated with having entrepreneurs, singular and corporate, invading previously held monopoly positions by providing new and improved products and services. This in turn represents the economic progress that generates welfare gains, in the technically economic context and not in the sense of providing public funds to needy populations. Through time, economic life is characterized as a continual process of monopoly establishment and systematic erosion via entrepreneurial activity. This entrepreneurial activity constitutes the observation of, and action upon, profit opportunities as evidenced by static monopoly rents.

We can think of dynamic pure competition as a process where naturally occurring monopoly is systematically eroded. It represents a kind of entropy that properly allocates resources in the production of current and future goods and services. The underlying characteristics of the competitive process are that it recognizes that economic imperfections are inherent; that economic man realizes this as a matter of course; and he or she is willing to

compensate economic agents who act to ameliorate these imperfections.

EMPIRICAL EVIDENCE OF COMPETITION IN THE PHARMACEUTICAL INDUSTRY

The issue of competition in the pharmaceutical industry is implicitly addressed in the works of Cocks and Virts (2, 3), who show a significant lack of price rigidity in various drug markets and among individual drug products. But its clearest discussion is given by Brozen (4):

> The Cocks data also destroy the common fiction of rigid prices for drugs and the fiction of inelastic demands for each of these patented products. Prices are remarkably flexible, thus producing large effects on market position. Leading products in the anti-infective market, for example, suffered price declines from 1962 to 1971 ranging from 7% (for product number 8) to 67% (for product number 3). The average price decline in this inflationary period for these products was 32%, while the consumer price index rose 34%. The price of leading anti-infectives fell by 51% in constant dollars. This is a remarkable record.
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> Sales of these products also demonstrate what a complete fiction is the story that the average physician pays no attention to prices in writing prescriptions. Product 11 among the anti-infectives languished at 0.1% of the market for 5 years until it had cut its price by 47%. At that point, its market share rose to 0.7%, a sixfold increase. Another 14% price cut raised its market share another 170%. Still further cuts over the next three years amounting to 12% raised its market share by still another 68%. This would seem to demonstrate a remarkably high price elasticity of demand for a branded patented product; particularly in view of the price cuts of competitive products.
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> Product number 3 had a fading market position from 1962 through 1969 "despite its price cuts, but then a 16% price cut in 1970 stopped the decline and added 14% to its market share. A further 27% cut in 1971 jumped its market share by another 40%. The market for ethical drugs responds remarkably vigorously to price changes, the myth of the price-insensitive prescribing physician to the contrary nothwithstanding.
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> There appears to be competition among products within each class despite whatever unique features each possesses. A product only singular enough to win 0.1% of the market over a five-year span won a 310% increase in market share when it cut its price relative to most of the other products in its market. A fading product turned itself around and reclaimed a major portion of its market position as it undertook similar price action."

One area that has been emphasized in economic theory is that price competition does not exist if a firm or group of firms can charge different prices to different segments of the market. In the pharmaceutical industry, this "market failure" has been emphasized relative to the prices charged to the elderly. It has been claimed that the elderly pay higher prices than the rest of the population. A recent study by Berndt et al. provides statistical evidence that the elderly do not.

A study by Reekie provides a more systematic analysis of pricing behavior regarding pharmaceutical products (5). This study provides a statistically strong inference that physicians are indeed sensitive to drug prices. The paper provides statistical evidence on pharmaceutical product price elasticity in which the coefficient of elasticity is determined to be greater than 1. Schwartzman also provides significant evidence on the amount of price competition in the pharmaceutical industry, especially in the area of antibiotics (6). The elderly generally pay higher prices than the rest of the population, and in some drug categories they pay lower prices (7).

INTERNAL ORGANIZATION CHARACTERISTICS OF THE PHARMACEUTICAL FIRM

The model of the pharmaceutical firm that we have constructed so far leaves us with a fundamental dichotomization of the firm. The dichotomy is between the firm consisting of the production of existing, marketed products, and the production of new products through research and development. The existence of this naturally leads us to question why the firm has to consist of these seemingly different activities. In other words, why could there not be firms who engage in research and development and only produce new products? They could sell these new products on the open market to firms whose specialized function it is to produce and sell the products developed by research firms. In addressing this issue, it is hoped that greater insight into the subtleties of the theory of the pharmaceutical firm can be garnered.

There are two basic elements as to why it is economically efficient to have both characteristics—current product production and new production—present

in one firm. The first element relates to corporate finance and the sources and uses of cash flows in the firm. The second element relates to the efficiencies that can be gained by resorting to markets within the firm (as opposed to external markets that are thought of in conventional microeconomic theory) (8a, 8b, 8c). It should be obvious from the discussion that follows there is an inherent interaction between these elements. This discussion also points out the entrepreneurial function in the firm and its implications for considering the efficiency of the firm.

A characteristic of the pharmaceutical industry, and very likely other R&D-intensive industries, is the interrelationship among new products, the cash flows of the firm, profit expectations, and the utility-enhancing characteristics of new drugs. This flow of economic events can be depicted in the following:

→ Portfolio of products composed of past R&D induced competitive products contributes to forming, maintaining, or raising expected present values of portfolio of current products and portfolio of research products. → Increasing cash flows (this relates to high accounting profits, discussed elsewhere in this article). → Increasing real R&D investment. → A portfolio of products that contains the previous products plus the newly developed products. → Determination of number of new drug products.

This is a series of events that occurs on a continuum, and the main characteristic is the internally generated cash flows that provide the wherewithal for R&D investment to come from the portfolio of existing products. To provide the necessary cash flows, this portfolio must contain products that have a range of price-marginal manufacturing cost differentials.

The relevance of the two elements, just discussed, can be elaborated on by considering the employment relation that is the primary aspect of the R&D process described above. Pharmaceutical R&D is really an investment in and accumulation of human capital through the employment of scientists and technicians. Like all human capital its "producing" aspects are necessarily embodied in individuals. Unlike normal labor (6) and any associated human capital characteristics that go with it (learning by doing), the human capital associated with pharmaceutical R&D creates complexities of monitoring and metering work effort. These difficulties exacerbate the contingent claims contracts, bounded rationality, opportunism, and information impactedness problems that would prevail if external markets were used. The use of a hierarchical system clearly presents a less costly alternative. In addition, it is evident from the previous description of the R&D process that the internal market organization allows the combining of the R&D inputs and yields output that is larger than the sum of the products if inputs are used separately.

We can now address the significance of a third element—what can be described as the entrepreneurial, combined element. The six stages of the R&D system process are really the steps that characterize going from invention to innovation, as discussed in the economics of innovation literature. The role of the concept of the entrepreneur is very crucial here. If we view the entrepreneur as the economic visionary, the importance of his or her role is especially apparent in stage 1 of our stage process. At this stage something more than mere "scientific" ability is required. It is also necessary to have the vision to convert "science" or knowledge into a useful product. However, each step of the system process requires entrepreneurial input.

The pharmaceutical firm amalgamates the diverse entrepreneurial activities that make up the complex process from invention through getting a marketable pharmaceutical product. In essence, we are making a distinction between the R&D inputs: scientist and scientist-entrepreneur. In many cases, the scientist does not have the full extent of entrepreneurial ability, and the firm provides the mechanism to achieve this. In addition, when dealing with both the scientist and scientist-entrepreneur, the problems with the Williamson (9) concepts are attenuated; resources are economized because the elements of complexity of contingent claims contracts, bounded rationality, information impactedness, and opportunism are separately prevalent in both the scientists' and scientist-entrepreneurs' activities. It is likely that there are distinctive aspects of the Williamson characteristics that are interactive, and this compounds the difficulties and thus makes the internal organization alternative less resource-costly.

In summary, the pharmaceutical R&D process lends itself to the efficiency gains that come from internally organizing these activities. These efficiencies are derived from the existence of the complex technological environment that surrounds the R&D process.

The essence of the theory that we are attempting to apply to the pharmaceutical industry has clearly been outlined by Demsetz. The crucial point is that there are

efficiency gains that are apparent not by comparing them with some ideal, but by comparing them with "real world" alternatives (10).

CONCLUSIONS

The model of the economics of the pharmaceutical industry that is developed here has four basic assumptions:

1. There is price sensitivity on the part of pharmaceutical consumers or, in particular, their agents-physicians, for new products as well as for existing products.
2. Research and development (R&D) serves as the primary catalyst for change among drug firms and is the focal point of entrepreneurial activity that ensures dynamic welfare gains (a continuum of static welfare losses being offset by concomitant higher utility, yielding benefits from new products and systematic erosion of monopoly power through price pressures for older products). As an institutional consideration, there will be a substantial number of firms intensively engaged in R&D activity. In the late 1990s there have been attempts at mega mergers in the industry that would create firms approaching the $100 billion or more sales amount. These mergers seem to be due to the significant rise in the R&D cost of developing new drugs—possibly exceeding $500 million.
3. The utility benefits from even small improvements in therapy can theoretically offset substantial differences in the prices of the new improvement relative to existing drug therapies. (This is basically a corollary to assumption 2).
4. The economic profitability of the industry will reflect all dynamic opportunity costs and will through time tend toward normal returns. As such, economic profitability serves as the ultimate guide to the proper allocation of resources as it does with the pure competitive model.

It has been the purpose of this article to apply certain aspects of economic analysis to the pharmaceutical industry. In doing this, we have described a dynamic competitive process that generates new products and serves as a mechanism that pushes us toward the optimal allocation of resources for the production of existing products. A model of the pharmaceutical firm was also presented. Finally, the welfare implications of the competitive process and the model of the firm were discussed.

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